

# RECLAMATION

*Managing Water in the West*

**PROGRESS REPORT 2004**

## **CONTRIBUTIONS TO DELISTING RIO GRANDE SILVERY MINNOW: EGG HABITAT IDENTIFICATION**



U.S. Department of the Interior  
Bureau of Reclamation



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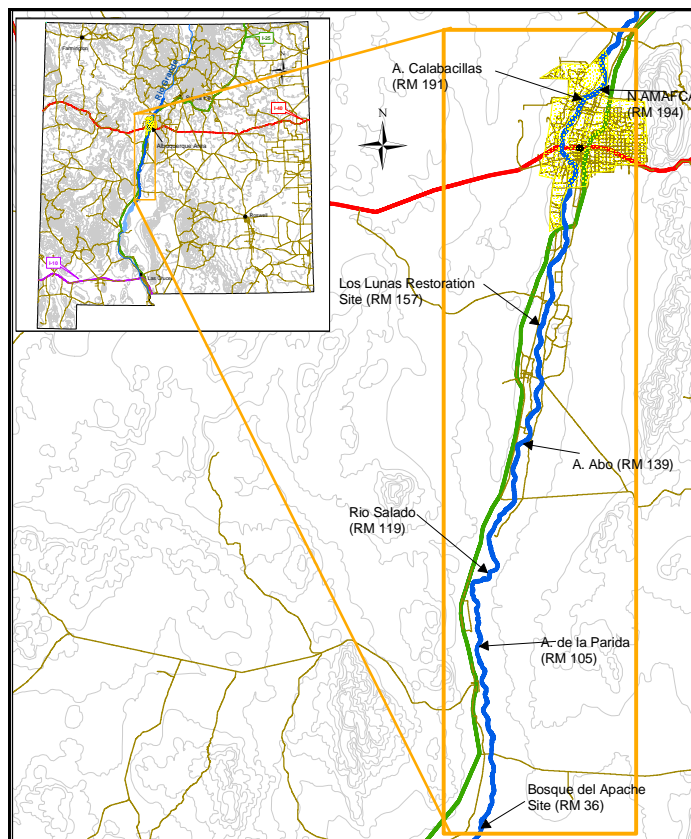
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## INTRODUCTION

The nursery habitat project was initiated in 2003 with the purpose of substantiating egg retention in constructed nursery habitat inlets. In the first year, two constructed inlets were sampled for silvery minnow and artificial egg retention while another existing, constructed inlet was sampled for artificial egg retention only. The data from the first study year indicated that inlet features did retain eggs, but that retention of the eggs varied greatly between inlets.

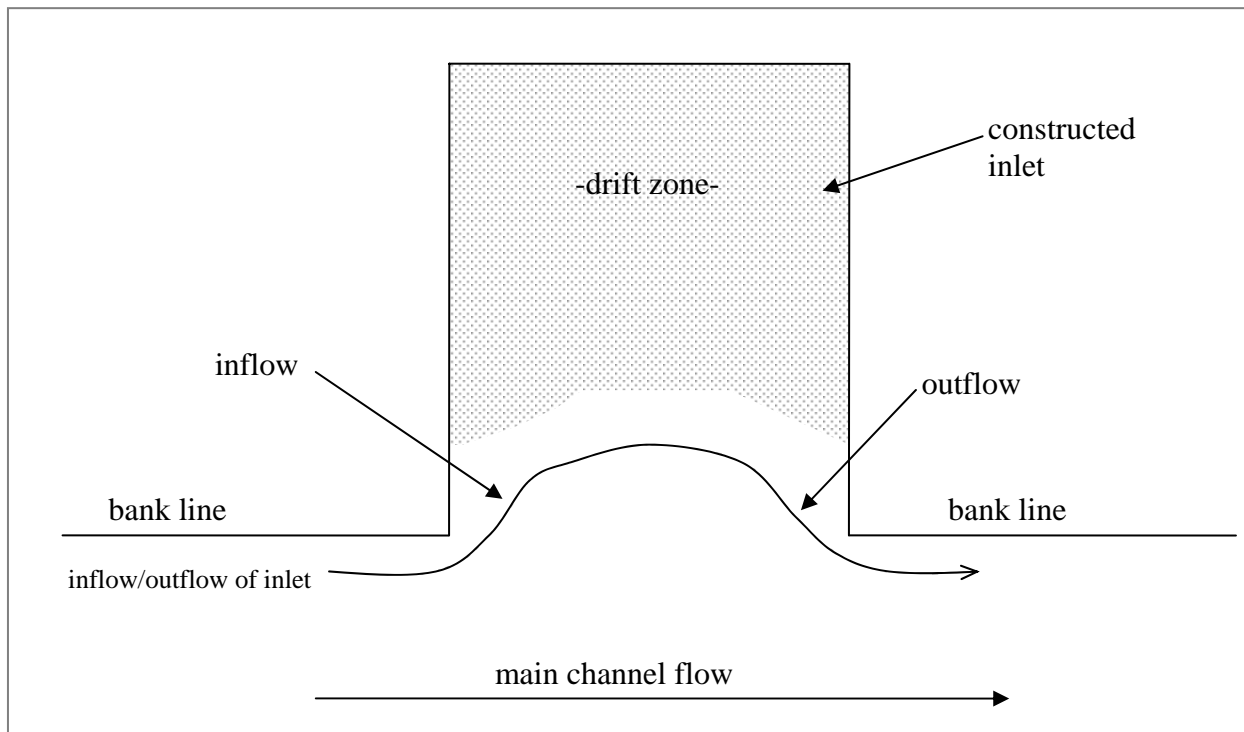
For the second year of the project, several stakeholders have contributed both funds and personnel to the collection and analysis of the field data. In addition to better understanding the physical features that contribute to the retention of silvery minnow and artificial eggs in constructed inlets, the project has been broadened to explore retention abilities of natural habitat features that currently exist in the Rio Grande. Several natural habitat features were examined at arroyos with a variety of confluence features: pro-grading fan deposits, purely inlet features and confluences with a variety of fan and inlet features (Figure 1). The confluences of Arroyo Calabacillas, Arroyo Abo, and Arroyo de la Parida were sampled as existing, natural sites (Figure 1). Inlets at North Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) confluence, and the Los Lunas Habitat Restoration Site were sampled this year as the constructed inlet features (Figure 1). In addition to the sampled sites, several other sites were observed during the sampling period but were not actually sampled: Rio Puerco confluence, Rio Salado confluence, Low Flow Conveyance Channel Outfall, and Bosque del Apache NWR Channel Widening Inlets.



**Figure 1.** Location Map showing locations of sample sites in the 2004 nursery habitat study.

The Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow) was listed as an endangered species in 1994 (U.S. Department of the Interior 1994). The declining silvery minnow population in the Rio Grande and Pecos River is thought to be due to the loss of habitat following dam construction (Bestgen and Platania 1991). Channel incision resulting from upstream dams has isolated floodplain habitat during years with reduced runoff discharge (Porter and Massong, 2005). Inundated floodplains provide suitable habitat for riverine larval fish to escape the current and initiate feeding (Coutant, 2004; Pease, 2004). The current Biological Opinion (U.S. Fish and Wildlife Service 2003) and the Middle Rio Grande Collaborative Program recognize the importance of habitat restoration in stabilizing the population, and recovery of the species. A main goal of this project is to increase Reclamation's understanding of silvery minnow habitat needs for recruitment and to improve our capability in constructing suitable habitat, especially habitat for the egg/larval lifestage (nursery habitat).

In 2003, constructed inlets were the focus of the study, in which successful inlets had both the formation of a 'drift zone' within the inlet, but also substantial inflow and outflow at the inlet mouth (Figure 2). The drift zone constitutes the water farther back in the inlet which has an un-measurable low velocity and direction. Although flow velocity within the drift-zone is almost non-existent, the water re-circulates and is not truly ponded.



**Figure 2.** Generalized plan view of the constructed inlets in 2003 at the Channel Widening Restoration Project at Bosque del Apache National Wildlife Refuge (BDA) on the Rio Grande.

## METHODS

### Study Sites

Sampling was conducted at natural and constructed sties with potential for retaining eggs (Figure 1). The confluences of Arroyo Calabacillas, Arroyo Abo, and Arroyo de la Parida are naturally occurring sites. The constructed features were inlets at North AMAFCA confluence,

and the Los Lunas Habitat Restoration. Several other sites were evaluated this spring but no egg retention experiments were conducted at the Rio Puerco confluence, Rio Salado confluence, Low Flow Conveyance Channel Outfall, and Bosque del Apache NWR Channel Widening Inlets.

### **Data Collection**

Types of data collected, collection methods and techniques in 2004 were similar to those employed by Porter and Massong (2003). Experiments were scheduled to coincide with the expected silvery minnow spawning period in mid-May. Artificial eggs (yellow beads) (Davin et al. 1999; Reinert et al. 2004) were released upstream of the sampling sites in 2 hour intervals throughout the sampling period to provide sufficient study material in addition to the silvery minnow eggs. Data was collected 2-7 consecutive days. The length of sampling was determined during the data collection period based on runoff/flow conditions and an ongoing review of the data collected.

Adult fish were identified in the field before returning them to the water. As in 2003, a grid of quadrats (Gammon, 1965; Kelso, 1996) were deployed within the sample area held in place by metal fence posts (Figure 3). Conforming to the shape of the study site, multiple lines of quadrats were deployed to create a matrix with 90-180 individual quadrats. Native spawned silvery minnow eggs and yellow beads were collected on the quadrats in the study area. In addition fish larvae and/or fish captured on the quadrats were counted and noted.



**Figure 3.** A set of deployed quadrats at the North AMAFCA Site in 2003 Photo taken by M.D. Porter.

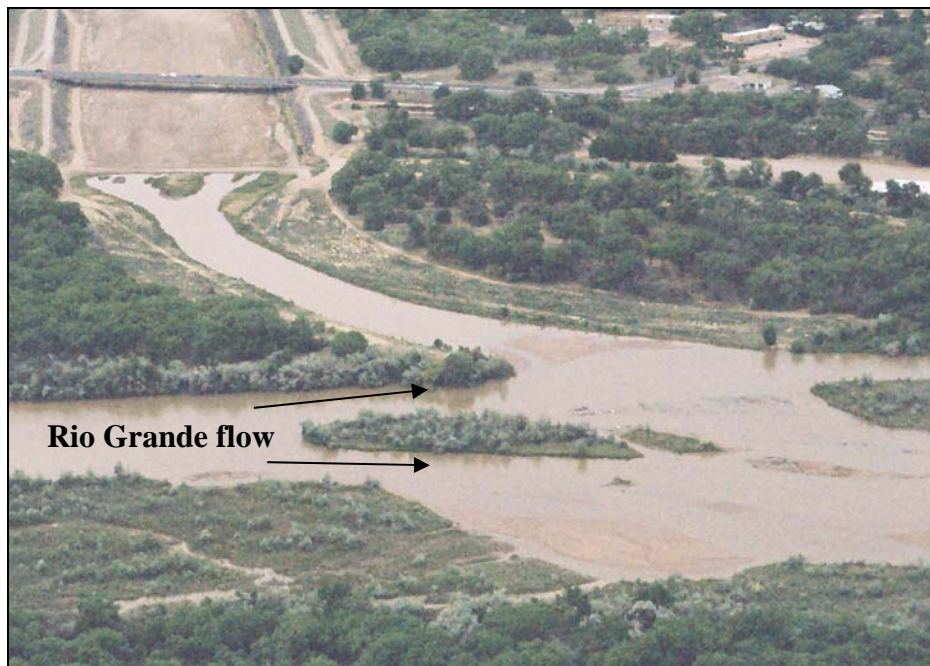
Quadrats were retrieved at 1-2 hour intervals, and all eggs, yellow beads, and fish larvae were counted. Silvery minnow eggs were collected in labeled container with river water and returned to the nursery habitat at the end of the day. A Moore egg collector (MEC) (Altenbach et al. 2000) was deployed for 15 minute intervals in the main flow of the Rio Grande during the data collection period. The number of yellow beads and minnow eggs collected in the Moore egg collectors were recorded for comparison to quadrat data.

Geographic data collected at each site was transformed into a Digital Elevation Model (DEM) to generate a topographic map of each site. The metal fence posts and quadrats are identified in each DEM with independent coordinates. The topographic data is in NAD83 UTM coordinates. Velocity data, flow direction and water depth data was also measured throughout the sample area, including at each fence post. The locations of the quadrats, yellow beads, minnow eggs, and fish larvae were added as map layers for spatial analysis and correlation with the physical data.

## RESULTS

### North Diversion Channel (created habitat)

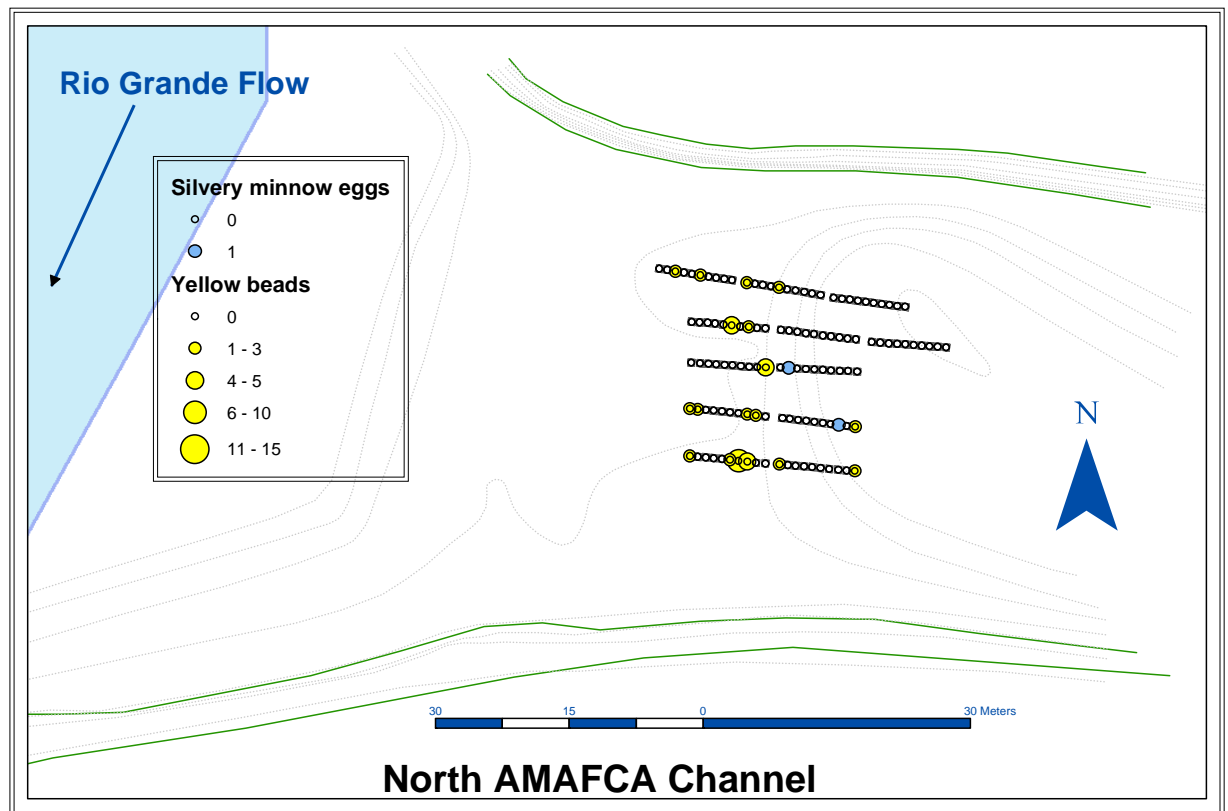
The inlet formed at the North Diversion Channel (N AMAFCA) is located at approximately river mile 194 on the east side of the Rio Grande just north of Albuquerque, NM (Figure 1). The habitat feature at this confluence is a well connected, back-water inlet with inflow from the Rio Grande year-round (Figure 4). The inlet is oriented at approximately 45° with the Rio Grande. The width (mouth) of the inlet is approximately 75 meters (from bank to bank) while the length is approximately 500 meters. Water from the Rio Grande (inflow) flows over a shallow sediment bar that partially blocks the inlet mouth; the drift zone begins just beyond the bar at about 50 meters from the Rio Grande.



**Figure 4.** N AMAFCA confluence (May 2004) with the Rio Grande forming an inlet that remains wet year round. The Rio Grande in the foreground is flowing from left to right; north is to the left of the picture. Photo taken by T. M. Massong

The physical data measured in 2004 showed that flows in the Rio Grande were twice as fast (1.0 m/s) as the flowing water across the inlet mouth bar (0.5 m/s). The depth data showed a similar trend; Rio Grande depth at the mouth was about 0.4 meter while flow depth on the bar was less than 0.2 meters. Sampling the entire drift zone was not performed due to excessive water depths, however the first 20 meters were sampled (Figure 5). In this limited area, the water depth ranged 0.4-0.9 meters. Beyond the sampling area, the water depth rapidly increased to over 1.0 meter.

A total of 48 beads, 4 eggs, and 3 larvae over six days were collected on the quadrats. Additional eggs and beads likely drifted beyond the limited sampling area, a process documented in 2003 at the Bosque del Apache National Wildlife Refuge (Porter and Massong, 2003).



**Figure 5.** Distribution of silvery minnow eggs and artificial eggs (yellow beads) at the North AMAFCA channel study site.

#### Arroyo Calabacillas (natural habitat)

Arroyo Calabacillas drains the West Mesa area near Albuquerque NM, joining the Rio Grande at approximately river mile 191 (Figure 1). At present, one dominant and four secondary



channels dissect the arroyo fan deposit (Figure 6). The most dominant channel, which is located on the downstream side of the fan, conveys the Corrales riverside drain water to the Rio Grande (Figure 5) and forms the largest inlet at this site. A small 'shelf' along the river's edge of the fan became inundated during the modest 2004 spring runoff which peaked at 3,000 cfs for this area. The arroyo is oriented at almost 90° with the Rio Grande; however the edge of the fan (the shelf area) interacts with the Rio Grande at every angle. During the 2004 runoff (3,000 cfs), the edge of the fan with young vegetation was partially flooded (approximately 15 meters onto the fan deposit). The main arroyo channel formed more of a traditional inlet connected to the Rio Grande. The inlet is approximately 14 meters across with a up-arroyo drift zone that extended more than 20 meters. Due to water flowing out of the arroyo, the drift zone location changed dramatically throughout the day. Measurements within the shelf area indicated predominately un-measurable water velocities except right at the edges where the water was inflowing or outflowing from the Rio Grande. The water depth varied on the shelf area but was less than 0.31 meters during the main runoff period. When the drain was not flowing significantly, the water velocities within the main arroyo inlet area were un-measurable. In fact, the inflow directly from the Rio Grande was un-measurable, as most of the inflow occurred from the shelf area. The main arroyo channel/inlet had water depths that ranged from 0.15 meters up to 0.55 meters, with a median depth of 0.41 meters. The Rio Grande just off the shelf area was approximately 0.70 meters deep with velocities approaching 1 meter/second.



**Figure 6.** Several inlets formed on the Arroyo Calabacillas fan where the primary and secondary arroyo channels meet the Rio Grande (May 2004). Thick vegetation is growing between the main arroyo channels. The Rio Grande flows from left to right; north is to the left of the picture. Photo taken by T. M. Massong.

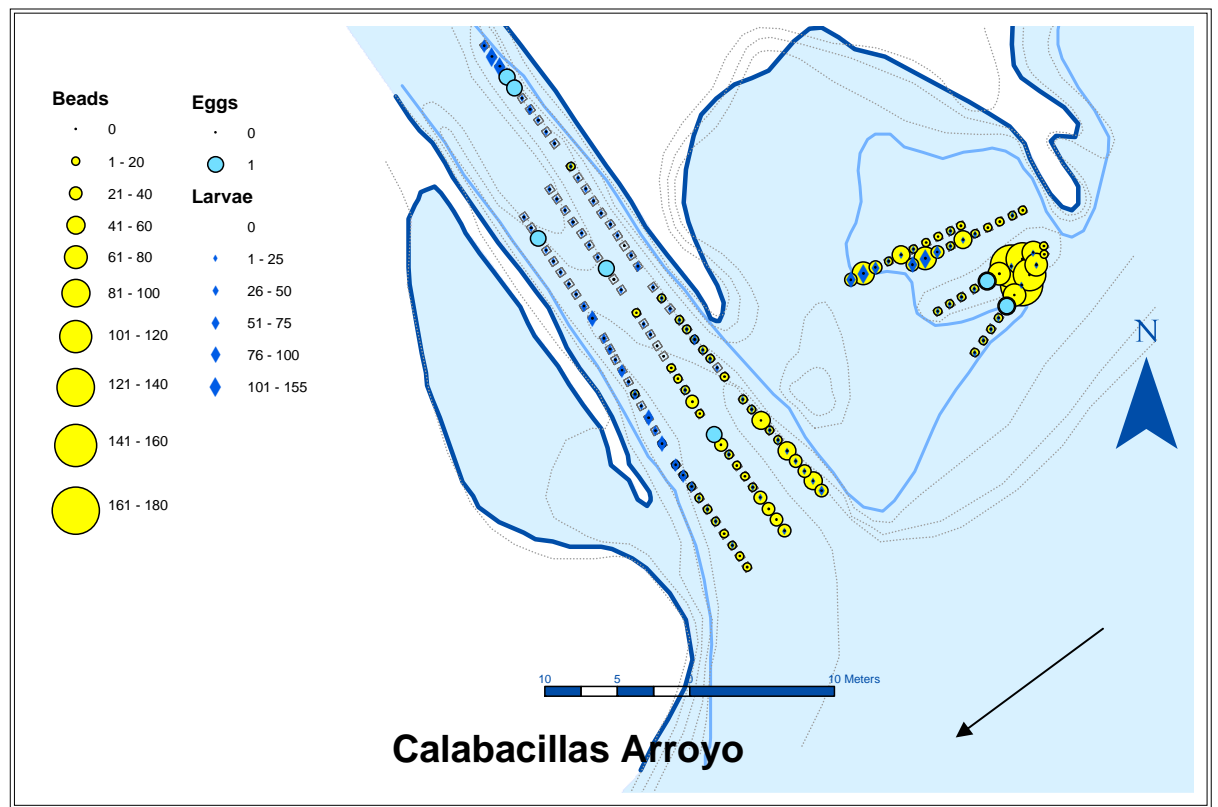
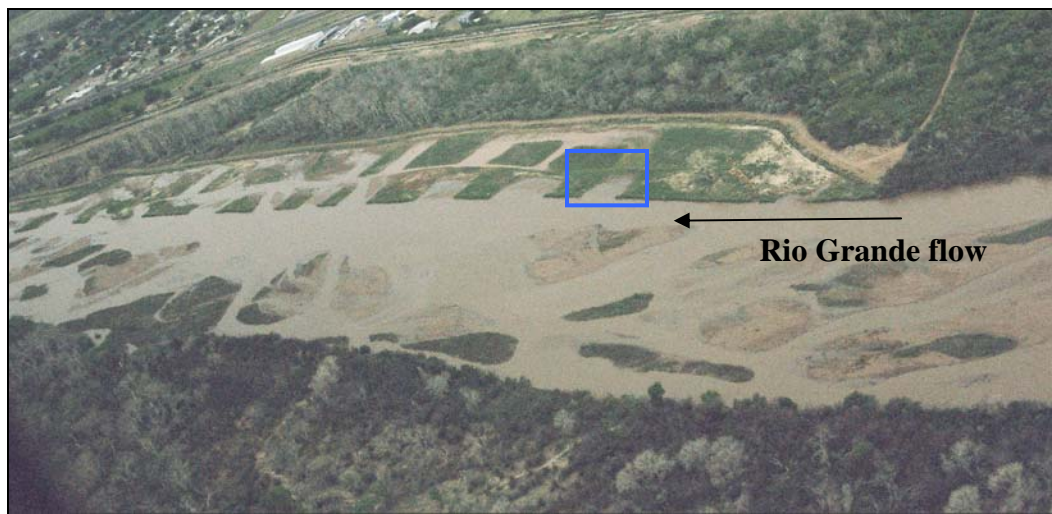


Figure 7. Distribution of silvery minnow eggs, yellow beads, and fish larvae at the Calabacillas Arroyo study site.

Most of the retained yellow beads at this site were collected and observed to linger on the shelf and next to the shelf within the inlet/main arroyo channel; in every release of yellow beads, the eggs were observed entering the arroyo inlet area from the adjacent shelf area. Few eggs were observed entering the inlet directly from the Rio Grande channel. A total of 1376 beads, 6 eggs, and 2046 larvae were collected on the quadrats at this site over four days of sampling (Figure 7). Laboratory identification of several larval fish collected from the shelf habitat indicated white suckers, fathead minnows, and longnose dace larvae present.

### **Los Lunas (restoration-constructed)**

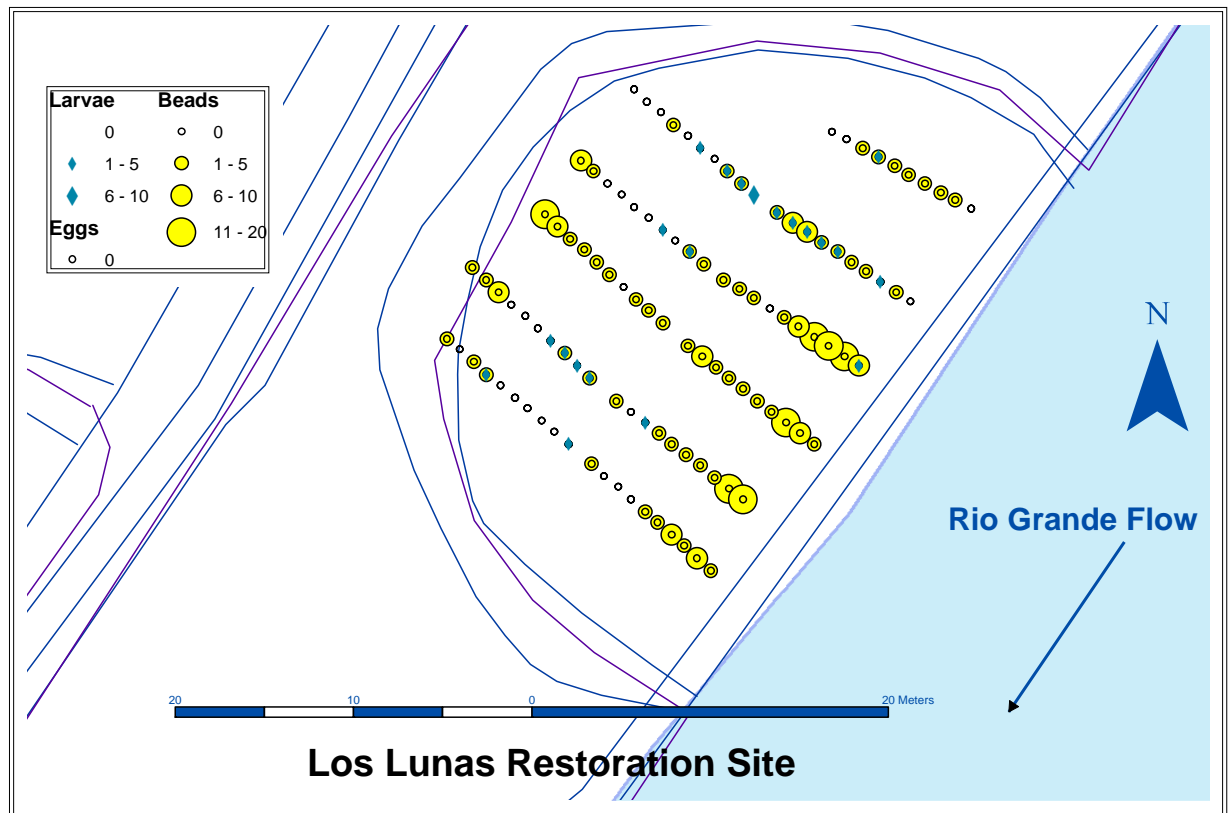
The Los Lunas Restoration Project area is located at approximately river mile 157, near Los Lunas, NM (Figure 1). The restoration project consists of several river-side inlets sculpted out of the old Rio Grande bank (a.k.a., Los Lunas inlets) at the upstream end of the project area (Figure 8). Inlet #1 was considered too small/unsuitable in 2003 to retain eggs as no drift zone had established, however with higher flows in 2004, the wetted area within the inlet extended nearly to the constructed high flow channel with a small drift zone at the back of the inlet. This inlet is approximately 35 meters wide with a length into the floodplain of 25 meters. Water depth on May 11, 2004 was 0.36 meters (median), while velocities ranged from un-measurable up to just over 1.0 meters/second. The median inflow rate was about 0.7 meters/second with a depth of approximately 0.35 meters. Inflow from the Rio Grande penetrated the inlet approximately 10 meters.



**Figure 8.** Los Lunas Habitat Restoration Site in May 2004 with inlet #1 highlighted by the blue square. Photo taken in May 2004 by T. M. Massong.

There was moderate capture success of yellow beads in this constructed inlet. A total of 352 yellow beads and 52 fish larvae were collected on the quadrats in six days of sampling (Figure 9). No silvery minnow eggs were collected in this inlet.

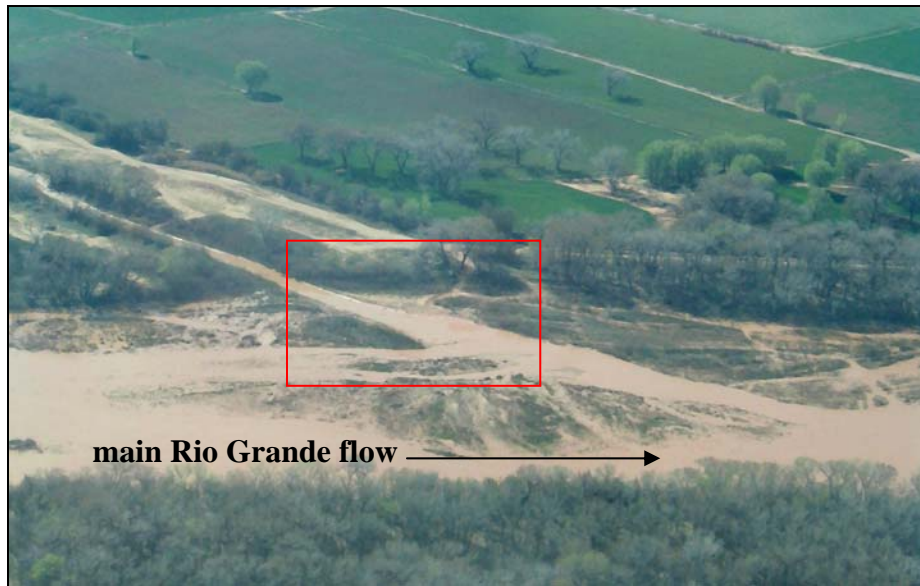




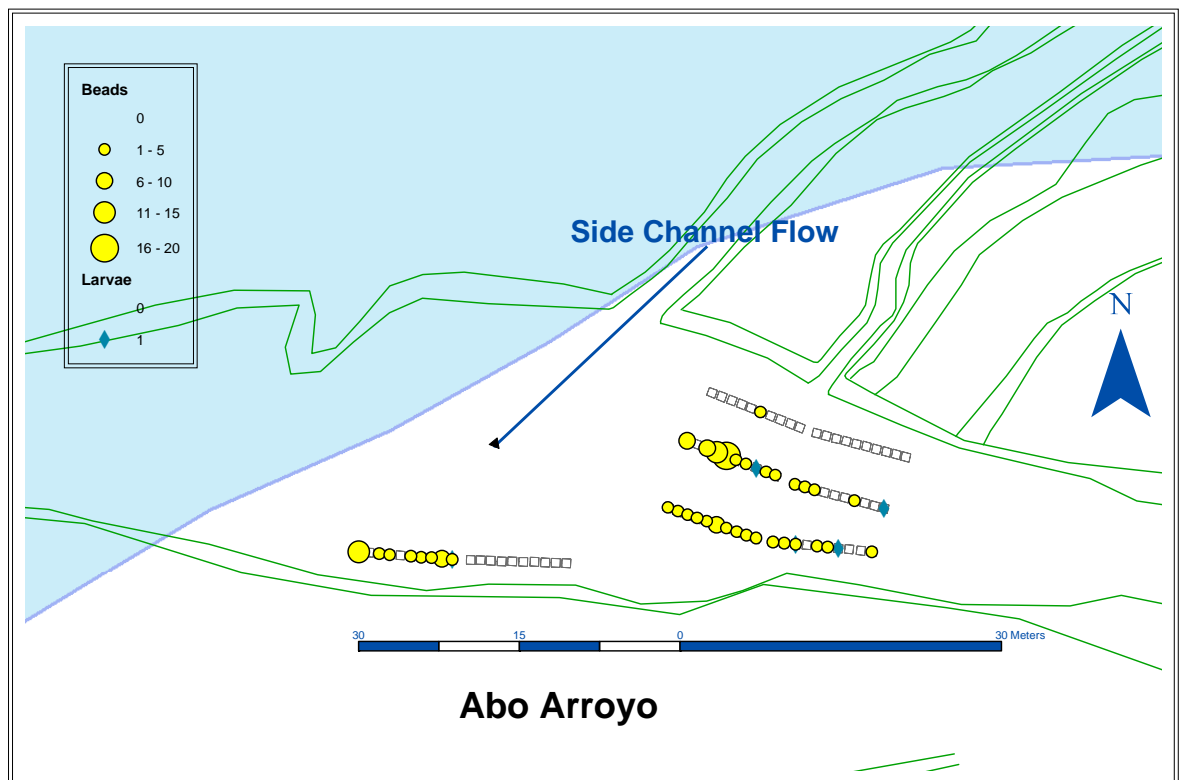
**Figure 9.** Distribution of yellow beads and fish larvae at the Los Lunas study site.

#### **Arroyo Abo (natural habitat)**

Arroyo Abo drains the northern edge of the Joyita Uplift, south of Bosque, NM joining the Rio Grande at approximately river mile 139 (Figure 1). At present, one dominant channel conveys the arroyo flows across the fan, (Figure 10). Two small Rio Grande side channels cut across the right-side fan deposits with most of the upstream deposits flooded during the spring flows in May 2004, about 2,000 cfs. The dominant arroyo channel formed a well defined inlet with drift zone (Figure 10). The inlet was approximately 30 meters wide and extended more than 40 meters up the arroyo. The Rio Grande side channel closest to the inlet turned 90° at the inlet mouth; this change in side channel flow direction directs the water away from the inlet/drift zone. As a consequence, flow into the inlet was minimal. Flow velocities in the side channel next to the inlet ranged from 0.3-0.6 meters/second, then dropped to less than 0.3 meters/second in front of the inlet mouth. Measurable water velocities ended 2-3 meters inside the inlet/quadrat area. The side channel was 0.3-0.8 meters in depth, while the inlet was about 0.3 meters depth.



**Figure 10.** Arroyo inlet formed at Arroyo Abo confluence with the Rio Grande in April 2004. Red square denotes the section of the confluence studied in May 2004. Photo taken by Reclamation's River Analysis Group.



**Figure 11.** Distribution of yellow beads, and fish larvae at the Abo Arroyo study site.

The capture success of yellow beads was low in the arroyo formed inlet. Secondary currents from the Rio Grande side channels appeared to dominate egg drift directions, which directed the eggs away from the formed drift zone. A total of 131 beads, and 5 larvae were collected on the quadrats in two days of sampling (Figure 11).

### **Arroyo de la Parida**

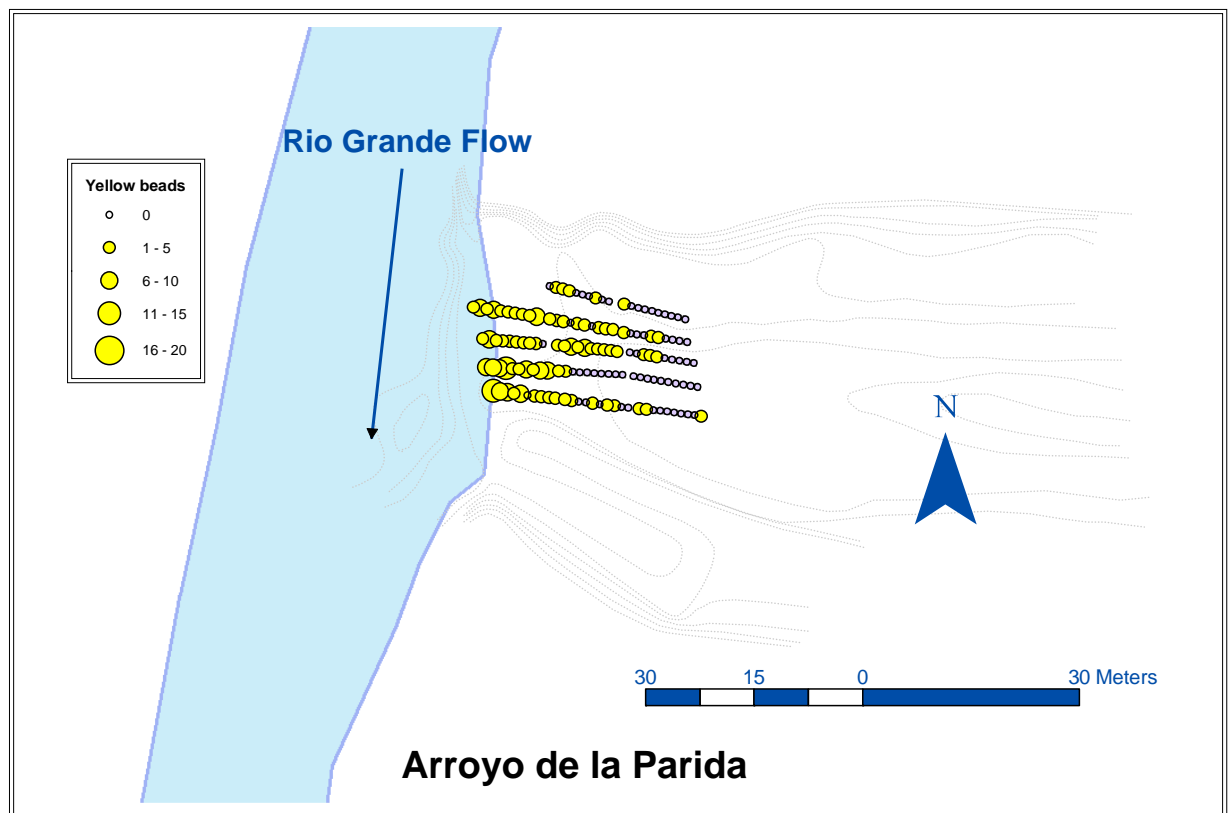
Arroyo de la Parida watershed drains the Joyita Uplift near Socorro NM and enters the Rio Grande from the east at approximately River Mile 105 (Figure 1). At present one main Arroyo de la Parida channel meets the Rio Grande (Figure 12) which created a wetted inlet in May 2004 at a Rio Grande flow of only 2,000 cfs. The confluence angle is rotated downstream 5-10 degrees. The width of the confluence is approximately 25 meters and extends about 50 meters up the arroyo. The depth of the Rio Grande entering the inlet was about 1.2 meters with a velocity of 0.7-0.9 meters/second. The inlet depth was 0.3-0.7 meters. Flow from the Rio Grande penetrated the inlet approximately 5 meters.



**Figure 12.** The confluence of Arroyo de la Parida with the Rio Grande on May 26, 2004 (1,150 cfs in the Rio Grande). The Rio Grande is flowing from right to left in the upper portion of the photograph; Low Flow Conveyance Channel (LFCC) Outfall at top of photo. Photo taken by T.M. Massong.

The capture success of yellow beads was moderate in the arroyo formed inlet. A total of 280 beads and 2 larvae were collected on the quadrats in seven days of sampling (Figure 13). No silvery minnow eggs were collected.

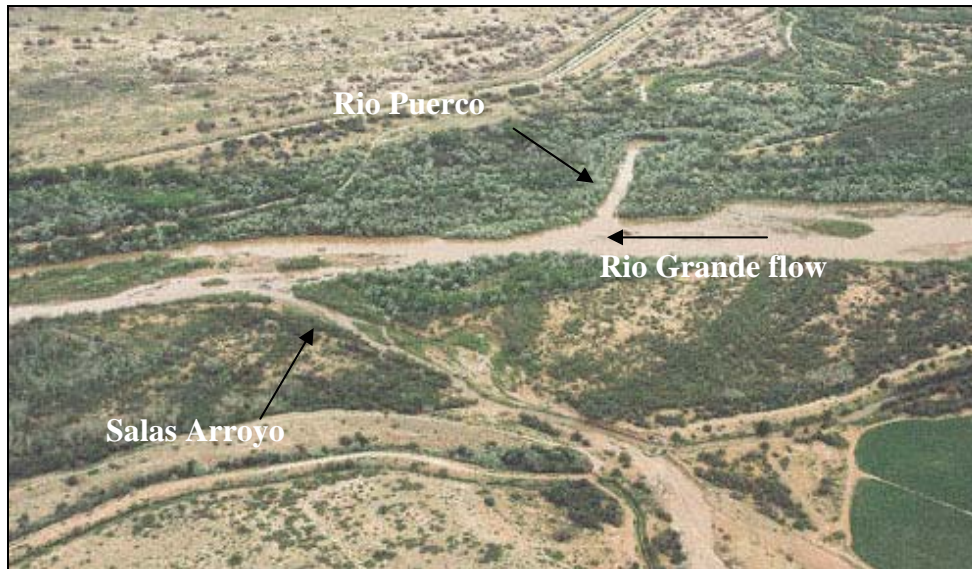




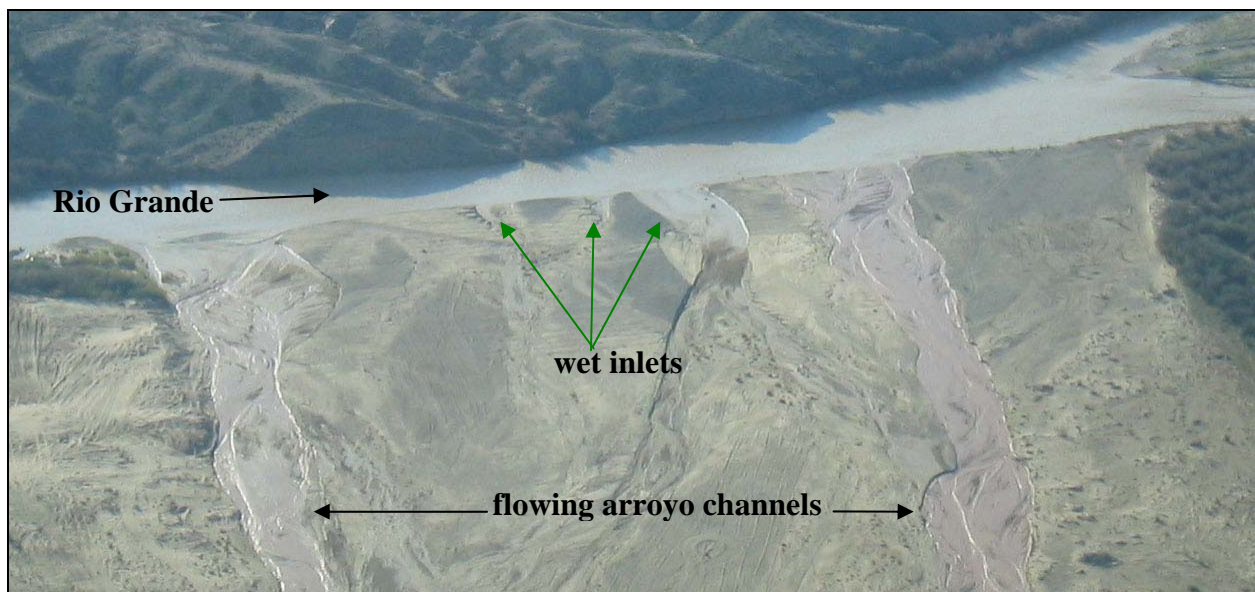
**Figure 13.** Distribution of yellow beads at the Arroyo de la Parida study site.

#### **OTHER HABITATS OBSERVED BUT NOT SAMPLED**

Four additional sites were designated as alternate sites in 2004: Rio Puerco confluence (Figure 14), Rio Salado confluence, Low Flow Conveyance Channel Outfall, and Bosque del Apache NWR Channel Widening Inlets. The two purely inlet sites, Rio Puerco (Figure 14) and the Low Flow Conveyance Channel Outfall (Figure 12) created inlets that were too deep and too muddy to sample. The Rio Salado confluence (Figure 15) formed 5 inlets in the Spring of 2004, but these inlets require relatively high flows to become inundated (about 3,000 cfs). At this location, the runoff peaked at 1,600 cfs in May 2004, a discharge too low to inundate the inlets. The Bosque del Apache NWR Channel Widening Inlets changed significantly since 2003 such that they were unsuitable for sampling. Some inlets partially filled with fine sediments that isolated their drift zones from the Rio Grande (Figure 16) while the others were eroded and no longer created drift zones.



**Figure 14.** Rio Puerco and Salas Arroyo confluences with the Rio Grande near La Joya, New Mexico in May 2004. Photo taken by T. M. Massong.



**Figure 15.** The confluence of the Rio Salado with the Rio Grande on April 7, 2004, Rio Grande flow of 2,650 cfs. The Rio Grande is flowing from left to right in the lower portion of the photograph; photo taken by Reclamation's AAO-River Analysis Team. The three small inlets in the middle are inundated by Rio Grande water.



**Figure 16.** Looking east across the Rio Grande toward ponded water in Inlet #2 at the Bosque del Apache National Wildlife Refuge Channel Widening Project (May 2004). The inlet filled with sediment during high flows in April 2004. Photo by M.D. Porter.

## SUMMARY

The most successful nursery habitat studied in this project is the Arroyo Calabacillas confluence area. In this location a combination of the shelf ‘feeding’ the inlet appears to be very effective at retaining eggs and larvae. Although Arroyo Abo results were not as good as desired, field observations indicated that larval fishes were heavily using the flooded fan deposits in similar fashion to the larval fishes at Arroyo Calabacillas. At both of these locations, vegetation on the shelf areas prohibited systematic sampling with the quadrats. Additional data needs to be collected on these shelf areas to better document their usefulness for egg and larval retention. A total of 64,777 beads, 24 eggs and 3 larvae were collected from the river in the Moore egg collectors. The quadrats collected 2187 beads, 12 eggs and 2108 larvae.

## ACKNOWLEDGMENTS

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